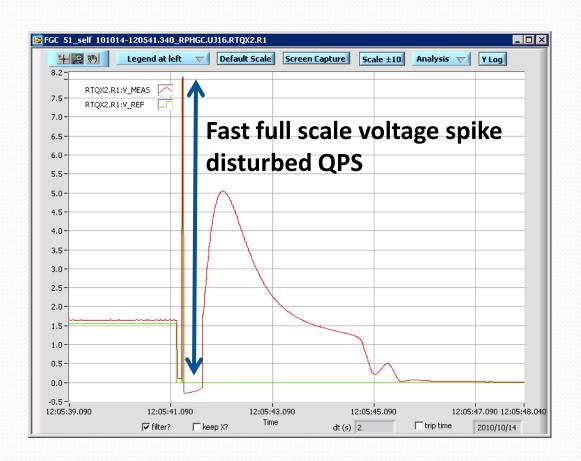
Investigation of the trip of RPHGC.UJ16.RTQX2.R1 at 12:05:41 on October 14th 2010

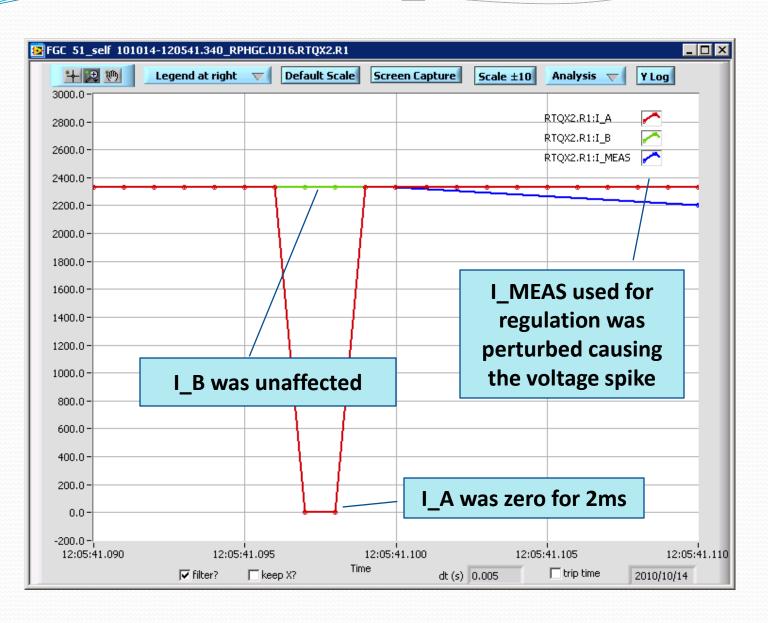
Quentin King Stephen Page Ludovic Charnay Hugues Thiesen Valerie Montabonnet

What happened?

- A glitch in the current measurement resulted in a full scale spike in the applied voltage
- This caused the QPS to fire the quench heaters



Current measurement L A was lost for 2ms

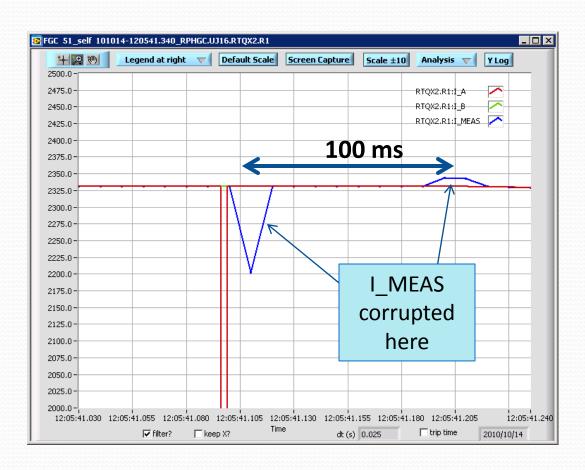


In more detail...

- A problem on the fibre signal from ADC A caused two consecutive milliseconds to have a bad status.
- The measurement I_A was forced to zero for these milliseconds.
- The software switched immediately to use the good channel only (I_B) and it SHOULD have stayed with channel B only for 200ms after I_A became good again.
- Due to a bug, this was not the actual behaviour.
- Instead, 20ms after I_A become good, the software switched back to using both channels.

I MEAS filter

 The I_MEAS value used for the regulation uses a filter with duration 120ms so the presence of the two zero samples in the history of I_A corrupted I_MEAS



Event log shows timings

<u> </u>	(RPI	HGC.UJ16.RTQX2.R1 event log (646 entries)			
1	4/10	/2010 03:25:15.807000 STATE.PC	IDLE	SET	
1	4/10	/2010 12:05:41.102000 MEAS.A.ST_MEAS	FLT_FRAME_ERR	SET	
1	14/10	/2010 12:05:41.102000 MEAS.A.ST_MEAS	FLT_NO_FRAME	SET	
I Λ Γ Λ Γ		/2010 12:05:41.102000 MEAS.A.ST_MEAS	V_MEAS_OK	CLR	
I_MEAS		/2010 12:05:♦ 102000 MEAS.A.ST_MEAS	I_MEAS_OK	CLR	
good agair	n	/2010 12:05:41.102000 DEVICE.WARNINGS	I_MEAS	SET	
good agair	'')	/2010 12:05:41.122000 MEAS.A.ST_MEAS	FLT_FRAME_ERR	CLR	
after only	,	/2010 12:05:41.122000 MEAS.A.ST_MEAS	FLT_NO_FRAME	CLR	
•		/2010 12:05:41.122000 MEAS.A.ST_MEAS	V_MEAS_OK	SET	
20ms		/2010 12:05:41.122000 MEAS.A.ST_MEAS	I_MEAS_OK	SET	
		/2010 12:05:41.122000 DEVICE.WARNINGS	I_MEAS	CLR	
1	14/10	/2010 12:05:41.202000 DEVICE.WARNINGS	FB_L00P	SET	
1	14/10	/2010 12:05:41.317000 FGC.ST_UNLATCHED	VS_POWER_ON	CLR	
1	14/10	/2010 12:05:41.317000 FGC.ST_UNLATCHED	PC_PERMIT	CLR	
1	14/10	/2010 12:05:41.317000 DIG.STATUS	SLOW_ABORT	SET	
1	14/10	/2010 12:05:41.317000 DIG.STATUS	PC_PERMIT	CLR	
1	14/10	/2010 12:05:41.317000 DIG.STATUS	AT00b OK	CLR	
1	14/10	/2010 12:05:41.317000 DIG.STATUS	VS_POWER_ON	CLR	
1	14/10	/2010 12:05:41.317000 VS.STATE	INVALID	SET	
1	14/10	/2010 12:05:41.317000 STATE.PC	STOPPING	SET	
1	14/10	/2010 12:05:41.320884 DIM.VS	STA SUB 4	ok	
1	14/10	/2010 12:05:41.320884 DIM.VS	STA SUB 3	ok	
1	14/10	/2010 12:05:41.320884 DIM.VS	STA SUB 2	ok	
1	14/10	/2010 12:05:41.320884 DIM.VS	STA SUB 1	ok	
1	14/10	/2010 12:05:41.320884 DIM.VS	STA VS VLOOP SATURATED	no	
1	14/10	/2010 12:05:41.320884 DIM.VS	TRG EXTERNAL FAST ABORT	FAULT	
1	14/10	/2010 12:05:41.320884 DIM.VS	STA OFF RECEIVED	YES	
		/2010 12:05:41.320884 DIM.VS	TRIGGER	SET	
		h: Meas_or	Save		4 / 646

History of ADC glitches

- 40 FGCs use external high precision ADCs (2 per FGC)
- These are in RB, RQF, RQD and the inner triplet converters
- Error counters are available in the FGC but are cleared following an FGC reset or on demand

Last reset dates of FGCs with external ADCs

F <u>i</u> le	<u>C</u> onnect	<u>D</u> isco	nnect	<u>G</u> ateway	<u>F</u> GC I	Da <u>t</u> abase <u>L</u> ist <u>A</u> nalysis	RBAC Help Connec	t devices: QX
. OP .	VS.PC	I_REF	I_MEAS	s v_ref	V_MEAS	1 / 40 / 424	Username: qking	Password: ********
	RD.IL	685.81	685.8		0.75	_	23/02/2010 10:04:00	
	RD.IL	717.00	717.0		0.69		22/07/2010 13:55:14	
	RD, IL	452.80	452.8		0.29		31/08/2010 15:21:21	
	RD, IL	325.17	325.1		0.31		23/02/2010 10:04:00	
	RD, IL	757,20	757.2		0.69	<u> </u>	20/07/2010 16:45:35	
	RD, IL	685.70	685.7		0.77	_	23/02/2010 10:04:00	
	RD, IL	716.68	716.6		0.72	_	22/07/2010 16:28:29	
	RD, IL	453.11	453.1		0.29		23/02/2010 10:04:00	
	RD.IL	326.27	326.2		0.30		02/09/2010 15:16:53	
	RD.IL	757.05	757.0		0.75	<u> </u>	20/07/2010 16:45:35	
	RD.IL	685.83	685.8		0.57		23/02/2010 10:04:00	
	RD.IL	716.85	716.84		0.60	-	08/04/2010 14:42:35	
	RD.IL	756.96	756.9		1.29	••• I	31/08/2010 15:38:07	
	RD.IL	685.97	685.9		0.57		23/02/2010 10:04:00	
	RD.IL	716.88	716.8		0.61		22/03/2010 09:11:15	
	RD.IL	756.70	756.7		0.98		20/07/2010 16:45:35	
	RD.IL	686.07	686.0		0.50		20/07/2010 13:41:01	
	RD.IL	717.20	717.2		0.51		20/07/2010 15:50:10	
	RD, IL	756.90	756.9:		0.83	<u> </u>	20/07/2010 16:45:35	
	RD.IL	685.80	685.8		0.54		23/02/2010 10:04:00	
	RD.IL	716.90	716.8		0.57	_	23/02/2010 10:04:00	
	RD.IL	757.19	757.1		0.74	<u> </u>	20/07/2010 16:45:35	
	RD.IL	685.45	685.4		0.79		07/04/2010 00:38:02	
	RD.IL	716.55	716.5		0.77		07/04/2010 00:37:54	
	RD.IL	453.11	453.1		0.34	<u> </u>	31/08/2010 15:10:32	
	RD.IL	325.24	325.24 756.41		0.34	-	31/08/2010 15:10:32	
	RD.IL	756.47			0.68		01/09/2010 16:32:19	
	RD.IL	685.63	685.6		0.77		17/09/2010 17:34:45	
	RD.IL	716.72	716.7		0.73		01/06/2010 08:30:21	
	RD.IL	452.74	452.7		0.31		23/02/2010 10:04:00	
	RD.IL	327.11	327.1		0.31	_	23/02/2010 10:04:00	
	RD.IL	756.83 408.22	756.8		0.50		01/09/2010 16:50:20	
	RD.IL		408.2		0.22		23/02/2010 10:04:00	
	RD.IL	289.46 408.16	289.49 408.1		0.21	RPHGC.UJ14.RTQX2.L1	23/02/2010 10:04:00	
	RD.IL						20, 72, 212	
	RD.IL	290.49	290.45				23/02/2010 10:04:00	
	RD.IL	408.25	408.24			RPARC. 0050. RgR. R5	20/02/2010 10:04:00	
	RD.IL	289.67 408.32	408.3		0.38 0.46		23/02/2010 10:04:00 04/04/2010 10:01:28	
	RD.IL RD.IL	408.32 289.12	289.1		0.46		08/04/2010 10:01:28	
·· ML	KD, IL	203.12	205.1.	2 0.45	0.42	KPRGC. USCSS. KTUXZ. LS	00/04/2010 11:06:13	

16 out of 40 were last reset in February

Color Colo	File <u>(</u>	<u>C</u> onnect	<u>D</u> iscor	nnect <u>(</u>	<u>G</u> ateway	<u>F</u> GC D	a <u>t</u> abase <u>L</u> ist <u>A</u> nalysi	s <u>R</u> BAC <u>H</u> elp o	connect devices: QX
N. R. M.	. OP . V	s.PC	I_REF	I_MEAS	V_REF	V_MEAS	16 / 40 / 424	Username: qkin	Password: ********
H. ED. II 452.80 452.80 0.27 0.30 RPHC. UR23.ROX.12 31/08/2010 15:02:21 21									
LILLED, II 325, 17 325, 17 0, 29 0, 31 RPFE, UA23, BB, A12 20/07/2010 10:04:00 20/07/2									
Liller Di									
LIMLED.II. 655.70 658.70 1.73 0.77 PPRE. UAZ?.RQD.RZ3 23/02/2010 10:04:00 22/07/2011 15:28:29 PRE. UAZRQT.RQT.RQZ.RQT.RQZ.RQZ.RQZ.RQZ.RQZ.RQZ.RQZ.RQZ.RQZ.RQZ									
Color Colo									
STALERD IL 453.11 453.11 0.23 0.29 0.30 SPECE UNEZY.ROX.R2 23/02/2010 10:04:00 0.00 0									
L.ML.RD.IL 326.27 326.27 0.23 0.30 EPHEC.UA27.RTQXZ.R2 20/09/2010 15:16:53 (.ML.RD.IL 757.05 757.05 0.80 1.00 RPTE.UA27.RE)A23 20/09/2010 15:16:53 (.ML.RD.IL 765.85 716.84 0.57 0.62 RPTE.UA43.RQD.R84 0.80/04/2010 15:18:07 0.80 0.80 0.80 0.80 0.80 0.80 0.80 0.							_		
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L.H.L.RD. II 756.85 716.84 0.57 0.62 RPHE. UA43.RQF.R34 31/08/2010 15:38:07 L.H.L.RD. II 756.96 756.96 0.24 0.95 RPHE. UA43.RB.R34 31/08/2010 15:38:07 L.H.L.RD. II 756.88 716.88 0.57 0.61 RPHE. UA47.RQF.R45 22/03/2010 09:11:15 L.H.L.RD. II 756.70 756.70 0.49 -0.31 RPHE. UA47.RQF.R45 20/07/2010 16:45:35 L.H.L.RD. II 717.20 717.20 0.47 0.52 RPHE. UA47.RQF.R45 20/07/2010 16:45:35 L.H.L.RD. II 716.90 756.90 -0.78 -0.13 RPHE. UA47.RQF.R65 20/07/2010 16:45:35 L.H.L.RD. II 685.85 685.81 0.50 0.54 RPHE. UA63.RQF.R67 L.H.L.RD. II 757.19 757.19 0.33 0.79 RPHE. UA67.RQF.R67 22/02/2010 10:04:00 L.H.L.RD. II 757.19 757.19 0.33 0.79 RPHE. UA63.RQF.R67 22/07/2010 16:45:35 L.H.L.RD. II 755.90 756.90 0.51 0.55 RPHE. UA67.RQF.R67 22/07/2010 16:45:35 L.H.L.RD. II 685.45 685.45 0.74 0.78 RPHE. UA63.RQF.R67 22/07/2010 16:45:35 L.H.L.RD. II 757.19 757.19 0.33 0.77 RPHE. UA63.RQF.R67 22/07/2010 10:04:00 L.H.L.RD. II 757.19 757.19 0.33 0.77 RPHE. UA63.RQF.R67 22/07/2010 10:04:00 L.H.L.RD. II 757.19 757.19 0.33 RPHE. UA63.RQF.R78 07/04/2010 00:37:54 L.H.L.RD. II 756.55 716.55 0.73 0.77 RPHE. UA63.RQF.R78 07/04/2010 00:37:54 L.H.L.RD. II 353.11 353.11 0.23 0.34 RPHE. UA63.RQF.R83.RQF.R81 01/09/2010 15:10:32 L.H.L.RD. II 357.11 357.12 0.32 0.32 RPHE. UA63.RQF.R81 01/09/2010 15:03:21 L.H.L.RD. II 756.83 756.83 1.00 0.57 RPHE. UA67.RQF.R81 01/09/2010 16:30:21 L.H.L.RD. II 452.74 452.73 0.27 0.27 RPHE. UA67.RQF.R81 01/09/2010 16:03:21 L.H.L.RD. II 452.74 452.73 0.27 0.27 RPHE. UA67.RQF.R81 01/09/2010 16:03:21 L.H.L.RD. II 408.25 408.25 0.33 0.38 RPHE. UA67.RQF.R5 L.H.L.RD. II 408.25 408.25 0.33 0.38 RPHE. UA67.RQF.R5 L.H.L.RD. II 408.35 408.35 0.38 0.38 RPHE. UA66.RQF.R5 L.H.L.RD. II 408.35 408.35 0.38 0.38 RPHE. UA66.RQF.R5 L.H.L.RD. II 408.									
C. M.L. RD. II 756.96 756.96 0.24 0.95 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.59 0.54 0.50 0.54 0.50 0.54 0.50 0.54 0.50 0.54 0.50 0.54 0.50 0.54 0.50 0.55 0.54 0.50 0.55							_		
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RPHE.VA87.RQD.A81									
RPHE.VA87.RQF.R81									
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Reference Refe									
RPTE.VA87.RB.A81									
Reference Company Co									
C.NL.RD.IL 283.46 289.46 0.19 0.21 RPHGC.UJ14.RTQX2.L1 23/02/2010 10:04:00 20/02/2010 20/02/2010 20/02/2010 20/02/2010 20/02/2010 20/02/2010 20/02/2010 20/02/2010 20/02/2010 20/02/2010 20/02/2010 20/02/2010								1 ' '	
C.NL.RD.IL 408.15 408.16 0.28 0.21 REFECUTION DESCRIPTION DE CONTROL									
C.NL.RD.TL 290.49 290.49 0.20 0.22 RPHGC.UJ16.RTQXZ.R1 23/02/2010 10:04:00 C.NL.RD.TL 408.25 408.25 0.33 0.38 RPHGC.UJ56.RTQXZ.R5 28/02/2010 10:04:00 C.NL.RD.TL 289.67 289.66 0.38 0.38 RPHGC.UJ56.RTQXZ.R5 23/02/2010 10:04:00 C.NL.RD.TL 408.32 408.31 0.31 0.44 RPHFC.USC55.RQX.L5 04/04/2010 10:01:28								1	
C.NL.RD.IL 408.25 408.25 0.33 0.38 RPHFC.0050.REN.RS 28/82/2010 10:04:00 C.NL.RD.IL 289.67 289.66 0.38 0.38 RPHFC.UJ56.RTQX2.R5 23/02/2010 10:04:00 C.NL.RD.IL 408.32 408.31 0.31 0.44 RPHFC.USc55.RQX.L5 04/04/2010 10:01:28								,,	
C.NL.RD.IL 289.67 289.66 0.38 0.38 RPHSC.UJ56.RTQX2.R5 23/02/2010 10:04:00 C.NL.RD.IL 408.32 408.31 0.31 0.44 RPHFC.USc55.RQX.L5 04/04/2010 10:01:28									
C.NL.RD.IL 408.32 408.31 0.31 0.44 RPMFC.USC55.RQX.L5 04/04/2010 10:01:28									
KFR0C. USCSS. KI QAZ. LS USC/ USC/ USC/ USC/ USC/ USC/ USC/ USC									
	XI II L. K.	D. 11	203.12	205,12	0.45	0,43	REMOC. OSCSS, RIQX2, ES	00/04/2010 11:00:1	

NO FRAME received error counts

F <u>i</u> le <u>(</u>	Connect	<u>D</u> iscor	nect	<u>G</u> ateway	<u>F</u> GC	Da <u>t</u> abase <u>L</u>	ist <u>A</u> nalysis	RBAC <u>H</u> elp	Connect	devices: QX	
OP . VS	S.PC	I_REF	I_MEAS	v_ref	V_MEAS	40 /	40 / 424	Username: 9	king	Password: *******	**
. NL. RI		685.81	685.80		0.74		-	0,0			
K. NL. RI		717.00	717.00		0.73		_	0,0			
. NL. RI		452.80	452.80		0.29		_	0,0			
, NL, RI		325.17	325.17		0.30		_	0,0			
. NL. RI		757.20 685.70	757.20 685.70		1.00 0.70			0,0			
. NL. RI		716.68	716.67				_	11 '			
. NL. RI . NL. RI		453.11	453.11		0.73		_	0,0			
. NL. RI		326.27	326.27		0.30		_	0,0			
C. NL. RI		757.05	757.09		1.19		_	0,0			
C. NL. RI		685.83	685.83		0.53			0,0			
. NL. RI		716.85	716.84		0.6:			0,0			
NL.RI		756.96	756.96		1.62			0,0			
NL.RI		685.97	685.97		0.59			0,0			
NL RI		716.88	716.88		0.6		_	0,0			
NL. RI		756.70	756.70		1.30		_	0,0			
. NL. RI		686.07	686.07		0.48			0,0			
.NL.RI		717.20	717.20		0.52		_	0,0			
. NL. RI		756.90	756.93		1.08			0,0			
, nl. ri	o.IL (685.80	685.81	0.47	0.52	RPHE. VA67.	RQD.A67	0,0			
. NL. RI		716.90	716.90	0.52	0.56			0,0			
. NL. RI	o.IL '	757.19	757.19	0.25	0.98	RPTE. UA67.	RB.A67	0,0			
, NL, RI	o.IL	685.45	685.49	0.75	0.79	RPHE. VA83.	RQD.A78	0,0			
. NL. RI	o.IL '	716.55	716.59	0.74	0.78	RPHE. UA83.	RQF.A78	0,0			
, NL, RI	O.IL 4	453.11	453,11	0.22	0.33	RPHFC. UA83	.RQX.L8	1844,1888			
, nl. ri	o.IL :	325.24	325.24	0.34	0.34	RPHGC.UA83	RTQX2.L8	0,0			
. nl. ri	o.IL '	756.47	756.47	7 0.53	0.73	RPTE. VA83.	RB.A78	0,0			
. NL. RI	O.IL I	685.63	685.64	0.71	0.79	RPHE. VA87.	RQD.A81	0,0			
K, NL, RI		716.72	716.72		0.72	RPHE. VA87.	RQF.A81	0,0			
. nl. ri	o.IL 4	452.74	452.74	0.25	0.32	RPHFC.UA87	.RQX.R8	4868,3811			
CHLE		327.11	327.11		0.30		_	2462,3999			
CHLE		756.83	756.83		0.96			0,0			
C. NL. RI		408,22	408,21		0.23		_	0,0			
C. NL. RI		289.46	289.46		0.2			0,0			
, NL. RI		408.16	408.16		0.0	111111111111111111111111111111111111111		0,0			
. NL. RI		290.49	290.50		0.22		.RTQXZ.R1	2,0			
. NL. RI		408.25	408.25		0.3		121221212	3050,2747			
. NL. RI		289.67	289.67		0.37		_	3924,2775			
. NL. RI		408.32	408,31		0.46		_	5156, 2532			
. NL. RI	J. 1L .	289.12	289,12	0.45	0.42	RPHGC.USC5	5. KTUXZ. L5	3449,2821			
	um no fr										Sen

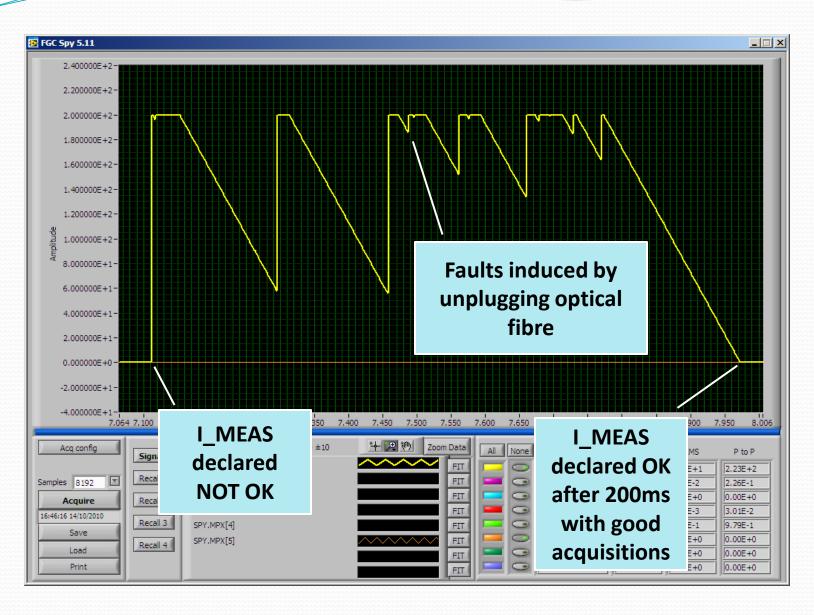
FRAME ERROR counts

File	<u>C</u> onnect	<u>D</u> isco	nnect	<u>G</u> ateway	<u>F</u> GC I	Da <u>t</u> abase	List	<u>A</u> nalysis	RBAC	<u>H</u> elp	Conn	ect devices: QX	
L. 0P.	VS.PC	I_REF	I_MEA	s v_ref	V_MEAS	40	/ 40	/ 424	User	name: 9	king	Password: *****	*****
	RD.IL	685.81	685.8		0.73		_		0,0				
	RD.IL	717.00	717.0		0.71				0,0				
	RD.IL	452.80	452.8		0.30				0,0				
	RD.IL	325.17	325.1		0.30				0,0				
	RD.IL	757.20	757.2		-0.26				0,0				
	RD.IL	685.70	685.7		0.77				0,0				
	RD.IL	716.68	716.6		0.73		_		0,0				
	RD.IL	453.11 326.27	453.1		0.28				0,0				
	RD.IL RD.IL	757.05	326.2 757.0		0.30 -0.29				0,0				
		685.83	685.8		0.57								
	RD.IL RD.IL	716.85	716.8		0.57		_		0,0				
	RD.IL	756.96	756.9		0.55				0,0				
	RD.IL	685.97	685.9		0.55				0,0				
	RD.IL	716.88	716.8		0.63				0,0				
	RD.IL	756.70	756.7		-0.18				0,0				
	RD.IL	686.07	686.0		0.49				0,0				
	RD.IL	717.20	717.2		0.43				0,0				
	RD.IL	756.90	756.9		-0.29				0,0				
	RD.IL	685.80	685.8		0.54				0,0				
	RD.IL	716.90	716.9		0.54				0,0				
	RD. IL	757.19	757.1		-0.22				0,0				
	RD.IL	685.45	685.4		0.80				0,0				
	RD.IL	716.55	716.5		0.77		_		0,0				
	RD. IL	453.11	453.1		0.77				184,75	2			
	RD.IL	325.24	325.2		0.34				0,0	_			
	RD. IL	756.47	756.4		-0.07				0,0	R			
	RD. IL	685.63	685.6		0.77				0,0	•			
	RD, IL	716.72	716.7		0.73				0,0				
	RD. IL	452.74	452.7		0.32				0,0	•	_	These need	
	RD.IL	327.11	327.1		0.30				0,0			THESE HEEU	
	RD. IL	756.83	756.8		0.17				0,0			ala a al duri d	
	RD. IL	408.22	408.2		0.22				0,0	4		checking!	
	RD. IL	289.46	289.4		0.21				0,0				
	RD. IL	408.16	408.1		0.22	AF100,001			1000				
	RD. IL	290.49	290.4		0.22				2,0	7 5			
	RD. IL	408.25	408.2		0.38				0,0				
	RD. IL	289.67	289.6		0.37			X2.R5	12,0				
	RD. IL	408.32	408.3		0.47				0,0				
	RD. IL	289.12	289.1		0.43				0,0				
									1,,,				
adc.	num_fram	err											Sen

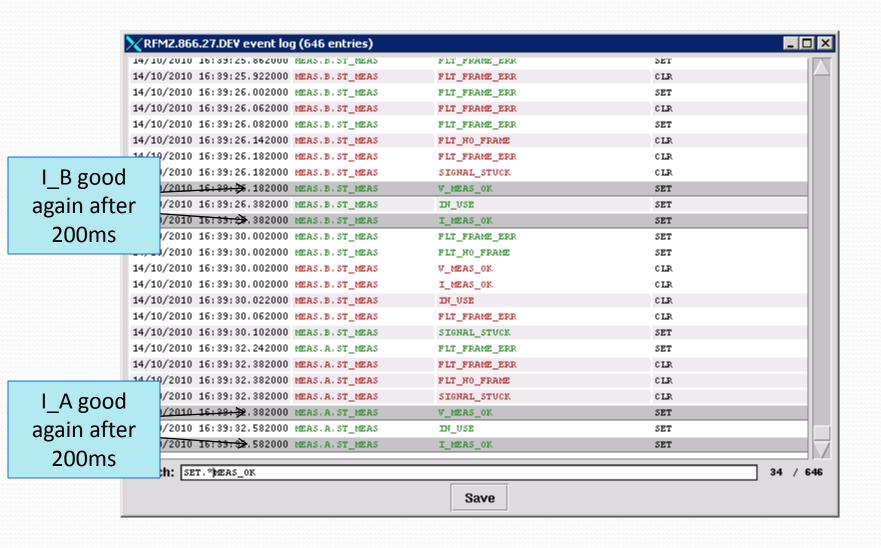
Software correction

- The missing functionality has been added to version 373.
- Now an acquisition channel must be good for 200ms before it will be used for regulation.
- This will ensure that the I_MEAS filter has only good data and should prevent a glitch in the current causing a glitch in the voltage.

200ms down counter added



Good behaviour of I_MEAS_OK for IA and IB



Deployment of new version

- New version (V373) was deployed at 18:30 on October 14th on RQX.R1 and RTQX2.R1 because this inner triplet is considered fragile and quenches are highly undesirable
- The new version should be deployed on all FGCs with external ADCs as soon as possible (next access?)
- The new version should be deployed everywhere at the next technical stop